**CURRICULUM VITA**

# Kelly D. Goodwin, Ph.D.

## Professional Address

National Oceanic and Atmospheric Administration (NOAA), Atlantic Oceanographic and Meteorological Laboratory (AOML), Ocean Chemistry and Ecosystems Division (OCED)
4301 Rickenbacker Causeway Miami, FL 33149, stationed at NMFS/SWFSC 8901 La Jolla Shores Drive, La Jolla, CA 92037. phone: 858 546-7142, kelly.goodwin@noaa.gov

## Current Title/Position/Grade

Microbiologist/ZP-IV/02

## Educational History

| | | |
|---|---|---|
| Ph.D., 1996 | California Institute of Technology | Environmental Engineering Science |
| Subject Minor*, 1993 | California Institute of Technology | Oceanography |
| M.S., 1991 | California Institute of Technology | Environmental Engineering Science |
| B.S. high honors, 1988 | University of Florida | Neurobiological Science |

*subject minor obtained in residence at Scripps Institute of Oceanography

## Professional Employment

| | | |
|---|---|---|
| 2003-present | NOAA | Microbiologist (hired as ZP-IV) |
| 2012-2017 | Weston Solutions Inc. | Molecular Biology Technical Advisor (via CRADA) |
| 2004-2011 | U Miami, RSMAS | Adjunct Assistant Professor |
| 2001-2003 | U Miami, CIMAS | Associate Scientist |
| 2000-2001 | U Miami, CIMAS | Assistant Scientist |
| 1999-2000 | U Miami, CIMAS | Senior Research Associate |
| 1995-1998 | US Geological Survey | National Research Council Postdoctoral Associate |

## Special Assignments

2011- present AOML Strategy, Execution, and Evaluation (SEE) Point of Contact to ensure timely and complete responses from AOML on SEE-related data calls and oversight of the research portfolio of the Ocean Chemistry and Ecosystem Division

## Honors and Awards

AOML Best Paper Award Nominee 2018

*A communal catalogue reveals Earth's multiscale microbial diversity. Nature 551: 457-463, doi:10.1038/nature24621 (2017) nominated in the Oceans and Great Lakes category.*

NOAA Certificate of Appreciation 2016

*In recognition of your pioneering work to establish a research program within NOAA for the study of ´omics and its importance to marine ecosystems globally*

Department of State Certificate of Appreciation 2015

*Bureau of Oceans and International Environmental and Scientific Affairs for contributions to the World Ocean Assessment Review Process*

NOAA Technology Transfer Award 2012

*Exemplary activities that promote the domestic transfer of science and technology developed within NOAA and result in the use of such science and technology by American industry or business, universities, State or local Government, or other non-Federal parties*

NOAA Certificates of Recognition or Appreciation:

| | |
|---|---|
| AOML Leadership in SEE-Related Integrated Response | 2012 |
| Contribution to Ecosystem Goals | 2010 |
| Advancing NOAA's Priorities through Regional Collaboration | 2012 |
| Takeda Techno-Entrepreneurship Award Finalist Commendation | 2001 |
| National Research Council Postdoctoral Associateship | 1995, 1996, 1997 |
| Recognition of USGS Special Act Service Award | 1997 |
| National Institute of Health Biotechnology Training Grant | 1994, 1995 |
| Caltech Tuition Award | 1989 |
| Soroptimist Society Fellowship | 1990 |
| University of Florida Graduation with High Honors | 1988 |
| Golden Key National Honor Society | 1987 |
| Phi Beta Kappa, early admission | 1986 |

## Publications

### Peer-Reviewed Journal Articles

1. E.A. Eloe-Fadrosh, N.C. Kyrpides, E.M. Wood-Charlson, T. Anderson, A.P. Arkin, G.A. Beattie, S. Bender, S.W. Chisholm, R. Cottingham, S.M. Forry, K.D. GOODWIN, B.L. Hurwitz, N.N. Ivanova, S.A. Jackson, C.A. Kellogg, C.L. Martin, M.E. Maxon, C. Mentzel, F. Meyer, N.J. Mouncey, T. Nielsen, P.J. Olsiewski N.R. Pace, A. Patrinos, L. Proctor, KD. .Pruitt, A. Smith, K.C. Soh, J.M. Tiedje, A. Visel, J.W. Weller, C. Wilson, J. Wortman, T. Woyke, M.A. Moran, C.M. Fraser, E.F. DeLong. A Roadmap for Microbiome Data Science. Science Policy Forum. In Review.

2. L.R. Thompson, M.F. Haroon, M.J. Cahill, D.K. Ngugi, G.J. Williams, J.T. Morton, R. Knight, K.D. GOODWIN, U. Stingl. Single-cell genomes of SAR11 and *Prochlorococcus* from the Red Sea: gene family composition and global distribution. In Review, Applied and Environmental Microbiology.

3. L.R. Thompson, J.G. Sanders, D. McDonald, A. Amir, J. Ladau, K.J. Locey, R.J. Prill, A. Tripathi, S.M. Gibbons, G. Ackermann, J.A. Navas-Molina, E. Kopylova, Y. Vázquez-Baeza, S. Janssen, J.T. Morton, S. Mirarab, Z.ZXu, M.F. Haroon, J. Kanbar, Q. Zhu, A. Gonzalez, S.J. Song, T. Kosciolek, N.A. Bokulich, J. Lefler, C.J. Brislawn, G.C. Humphrey, S.M. Owens, J. Hampton-Marcell, D. Berg-Lyons, V. McKenzie, N. Fierer, J.A. Fuhrman, A. Clauset, R.L. Stevens, A. Shade, K.S. Pollard, K.D. GOODWIN, J.K. Jansson, J.A. Gilbert, R. Knight & The Earth Microbiome Project Consortium. A communal catalogue reveals Earth's multiscale microbial diversity. Nature 551: 457-463, doi:10.1038/nature24621 (2017).

4. Y. Cao, M.R. Raith, P.D. Smith, J.F. Griffith, S.B. Weisberg, A. Schriewer, A. Sheldon, C. Crompton, G.G. Amenu, J. Gregory, J. Guzman, K.D. GOODWIN, L. Othman, M. Manasjan, S. Choi, S. Rapoport, S. Steele, T. Nguyen, and X. Yu. Regional assessment of human fecal contamination in southern California coastal drainages. International Journal of Environmental Research and Public Health 14(8):874, doi:10.3390/ijerph14080874 (2017).

5. K.D. GOODWIN, A. Schriewer, A. Jirik, K. Curtis, A. Crumpacker. Consideration of natural sources in a bacteria TMDL – Lines of evidence, including beach microbial source tracking. Environmental Science and Technology 51(14):7775-7784, doi: 10.1021/acs.est.6b05886 (2017).

6. C. Staley, T. Kaiser, M.L. Gidley, I.C. Enochs, P.R. Jones, K.D. GOODWIN, C.D. Sinigalliano, M.J. Sadowsky, and C.L. Chun. Differential impacts of land-based sources of pollution on the microbiota of southeast Florida coral reefs. Applied and Environmental Microbiology 83(10): e03378-16, doi:10.1128/AEM.03378-16 (2017).

7. K.D. GOODWIN, L.R. Thompson, B. Duarte, T. Kahlke, A.R. Thompson, J.C. Marques, and I. Caçador. DNA sequencing as a tool to monitor marine ecological status. Frontiers in Marine Science 4(107):1-14, doi: 10.3389/fmars.2017.00107 (2017).

8. K.D. GOODWIN, S. Gruber, M. Vondrak, A. Crumpacker. Watershed assessment with beach microbial source tracking and outcomes of resulting gull management. Environmental Science and Technology 50(18):9900-9906, doi: 10.1021/acs.est.6b02564 (2016).

9. E. Stulberg, D. Fravel, L.M. Proctor, D.M. Murray, J. LoTempio, L. Chrisey, J. Garland, K. GOODWIN, J. Graber, M.C. Harris, S. Jackson, M. Mishkind, D.M. Porterfield, A.Records. An assessment of US microbiome research. NATURE MICROBIOLOGY 1:1-7. Article number: 15015, doi: 10.1038/NMICROBIOL.2015.15 (2016).

10. A. Kopf, M. Bicak, R. Kottmann, J. Schnetzer, I. Kostadinov, K. Lehmann, A. Fernandez-Guerra, C. Jeanthon, E. Rahav, M. Ullrich, A. Wichels, G. Gerdts, Pa. Polymenakou, G. Kotoulas, R. Siam, R.Z Abdallah, E.C Sonnenschein, T. Cariou, F. O'Gara, S. Jackson, S.i Orlic, M. Steinke, J. Busch, B. Duarte, I. Caçador, J. Canning-Clode, O. Bobrova, V. Marteinsson, E.Reynisson, C. Magalhães, L. Gian. M. Luna, G. Marina, Q. Carolin. R. Löscher, A. Kremp, M.E DeLorenzo, L. Øvreås, J. Tolman, J. LaRoche, A. Penna, M. Frischer, T. Davis, B. Katherine, C.P Meyer, S. Ramos, C. Magalhães, F. Jude-Lemeilleur, M.L. Aguirre-Macedo, S. Wang, N. Poulton, S. Jones, R. Collin, J.A Fuhrman, P.Conan, C. Alonso, N. Stambler, K. GOODWIN, et al. The ocean sampling day consortium. GigaScience 4(1):1-5, doi: 10.1186/s13742-015-0066-5 (2015).

11. J.D. Happel, Y. Mendoza, Y., and K.D. GOODWIN. A reassessment of the soil sink for atmospheric carbon tetrachloride based upon static flux chamber measurements. Journal of Atmospheric Chemistry 71(2), 113-123, doi 10.1007/s10874-014-9285-x (2014).

12. N. Davies, D. Field, L. Amaral-Zettler, M.S. Clark, J. Deck, A. Drummond, D.P. Faith, J. Geller, J. Gilbert, F.O. Glöckner, P.R. Hirsch, J.A. Leong, C. Meyer, M. Obst, S. Planes, C. Scholin, A.P. Vogler, R.D. Gates, R. Toonen, V. Berteaux-Lecellier, M. Barbier, K. Barker, S. Bertilsson, M. Bicak, M.J. Bietz, J. Bobe, L. Bodrossy, A. Borja, J. Coddington, J. Fuhrman, G. Gerdts, R. Gillespie, K.D. GOODWIN, et al. The founding charter of the Genomic Observatories Network. GigaScience 3(2):1-5, doi: 10.1186/2047-217X-3-2 (2014).

13. A.M. Cox and K.D. GOODWIN. Sample preparation methods for quantitative detection of DNA by molecular assays and marine biosensors. Marine Pollution Bulletin 73(1):47-56, doi: 10.1016/j.marpolbul.2013.06.006 (2013).

14. D.L. Ebentier, K.T. Hanley, Y. Cao, B.D. Badgley, A.B. Boehm, J.S. Ervin, K.D. GOODWIN, M. Gourmelon, J.F. Griffith, P.A. Holden, C.A. Kelty, S. Lozach, C. McGee, L.A. Peed, M. Raith, H. Ryu, M.J. Sadowsky, E.A. Scott, J. Santo Domingo., A. Schriewer, C.D. Sinigalliano, O.C. Shanks, L.C. Van de Werfhorst., D. Wang, S. Wuertz, J.A. Jay. Evaluation of the repeatability and reproducibility of a suite of PCR-based microbial source tracking methods. Water Research 47(18):6839-6848, doi: 10.1016/j.watres.2013.01.060 (2013).

15. J.R. Stewart, A.B. Boehm, E.A. Dubinsky, T.-T. Fong, K.D. GOODWIN, J.F. Griffith, R.T. Noble, O.C. Shanks, K. Vijayavel, S.B. Weisberg. Recommendations following a multi-laboratory comparison of microbial source tracking methods. Water Research 47(18):6829-6838, doi: 10.1016/j.watres.2013.04.063 (2013).

16. A. Schriewer, K.D. GOODWIN, C.D. Sinigallinao, A.M. Cox, D. Wanless, J. Bartkowiak, D.L. Ebentier, K.T. Hanley, J. Ervin, L.A. Deering, O.C. Shanks, L.A. Peed, W.G. Meijer, J.F. Griffith, J. Santo Domingo, J.A. Jay, P.A. Holden, and S. Wuertz. Performance evaluation of canine-associated *Bacteroidales* assays in a multi-laboratory comparison study. Water Research 47(18):6909-6920, doi: 10.1016/j.watres.2013.03.06 (2013).

17. C.D. Sinigalliano, J. Ervin, L.C. Van de Werfhorst, D. Wang, D. Wanless, J. Bartkowiak, B. Layton, M. Raith, A.B.B. Schriewer, C. Lee, K.D. GOODWIN, J. Lee, A.B. Boehm, R. Noble, P.A. Holden, J. A. Jay, S. Wuertz, M. Byappanhalli, R. Whitman, M.J. Sadowsky, W. G. Meijer, E. Balleste, M. Gourmelon, J.F. Griffith, H. Ryu, and J.W. Santo Domingo. Multi-laboratory evaluations of the performance of *Catellicoccus marimammalium* PCR assays developed to target gull fecal sources. Water Research 47(18):6883-6896, doi: 10.1016/j.watres.2013.02.059 (2013).

18. K.D. GOODWIN, M. McNay, Y. Cao, D. Ebentier, M. Madison, J.F. Griffith. A multi-beach study of *Staphylococcus aureus*, MRSA, and enterococci in southern California seawater and beach sand. Water Research 46(13):4195-4207, doi: 10.1016/j.watres.2012.04.001 (2012).

19. K. Yamahara, L. Sassoubre, K.D. GOODWIN and A. Boehm. Occurrence and persistence of human pathogens and indicator organisms in beach sands along the California coast. Applied and Environmental Microbiology 78(6):1733-1745, doi: 10.1128/AEM.06185-11 (2012).

20. J. Gooch-Moore, K.D. GOODWIN, C. Dorsey, R.D. Ellender, J.B. Mott, M. Ornelas, C. Sinigallano, B. Vincent, D. Whiting, S.H. Wolfe. New USEPA Water Quality Criteria by 2012: GOMA concerns and recommendations. Journal of Water and Health 9(4):718-733, doi: 10.2166/wh.2011.15 (2011).

21. Y. Mendoza, K. GOODWIN, and J.D. Happell. Microbial removal of atmospheric carbon tetrachloride in bulk aerobic soils. Applied and Environmental Microbiology 77(17):5835-5841, doi: 10.1128/AEM.05341-11 (2011).

22. E.J. Viau, K.D. GOODWIN, K.M. Yamahara, B.A. Layton, L.M. Sassoubre, S.L. Burns, H.I. Tong, S.H. Wong, Y. Lu, A.B. Boehm. Bacterial pathogens in Hawaiian coastal streams--associations with fecal indicators, land cover, and water quality. Water Research 45(11):3279-3290, doi: 10.1016/j.watres.2011.03.033 (2011).

23. M.R. Diaz, J.W. Jacobson, K.D. GOODWIN, S.A. Dunbar, J.W. Fell. Molecular detection of harmful algal blooms (HABs) using locked nucleic acids and bead array technology. Limnology and Oceanography Methods 8(6):269-284, doi: 10.4319/lom.2010.8.269 (2010).
24. K.D. GOODWIN and M. Pobuda. Performance of CHROMagar™ Staph aureus and CHROMagar™ MRSA for detection of *Staphylococcus aureus* in beach water and sand – comparison of culture, agglutination, and molecular analyses. Water Research 43(19):4802-4811, doi: 10.1016/j.watres.2009.06.025 (2009).
25. A.B. Boehm, J. Griffith, C. McGee, T.A. Edge, H.M. Solo-Gabriele, R. Whitman, Y. Cao, M. Getrich, J.A. Jay, D. Ferguson, K.D. GOODWIN, C.M. Lee, M. Madison, S.B. Weisberg. Faecal indicator bacteria enumeration in beach sand: a comparison study of extraction methods in medium to coarse sands. Journal of Applied Microbiology 107(5):1740-1750, doi: 10.1111/j.1365-2672.2009.04440.x (2009).
26. K.D. GOODWIN, L. Matragano, D. Wanless, C. Sinigalliano, M.J. LaGier. A preliminary investigation of fecal indicator bacteria, human pathogens, and source tracking markers in beach water and sand. Environmental Research Journal 2(4):395-417, novapublishers.com/catalog/product_info.php? products_id=21172 (2009).
27. M.J. LaGier, J.W. Fell, K.D. GOODWIN. Electrochemical detection of harmful algae and other microbial contaminants in coastal waters using hand-held biosensors. Marine Pollution Bulletin 54(6):757-770, doi: 10.1016/j.marpolbul.2006.12.017 (2007).
28. I.B. Baums, K.D. GOODWIN, T. Kiesling, D. Wanless, M.R. Diaz, J.W. Fell. Luminex detection of fecal indicators in river samples, marine recreational water, and beach sand. Marine Pollution Bulletin 54(5):521-536, doi: 10.1016/j.marpolbul.2006.12.018 (2007).
29. M.J. LaGier, C.A. Scholin, J.W. Fell, J. Wang, K.D. GOODWIN. An electrochemical RNA hybridization assay for detection of the fecal indicator bacterium *Escherichia coli*. Marine Pollution Bulletin 50(11):1251-1261, doi:10.1016/j.marpolbul.2005.04.034 (2005).
30. K.D. GOODWIN, R. Tokarczyk, F.C. Stephens, E.S. Saltzman. Description of toluene inhibition of methyl bromide biodegradation in seawater and isolation of a marine toluene-oxidizer that degrades methyl bromide. Applied and Environmental Microbiology 71(7):3495-3503, doi: 10.1128/AEM.71.7.3495-3503.2005 (2005).
31. K.D. GOODWIN, S.A. Cotton, G. Scorzetti, J.W. Fell. A DNA hybridization assay to identify toxic dinoflagellates in coastal waters: detection of *Karenia brevis* in the Rookery Bay National Estuarine Research Reserve. Harmful Algae 4(2):411-422, doi: 10.1016/j.hal.2004.07.005 (2005).
32. Yvon-Lewis, S.A., D.B. King, R. Tokarczyk, K.D. GOODWIN, E.S. Saltzman, J.H. Butler. Methyl bromide and methyl chloride in the Southern Ocean. Journal of Geophysical Research 109(C2): CO2008, doi:10.1029/2003JC001809 (2004).
33. R. Tokarczyk, K.D. GOODWIN, E.S. Saltzman. Methyl chloride and methyl bromide degradation in the Southern Ocean. Geophysical Research Letters 30(15):1808, doi: 10.1029/2003GL017459 (2003).
34. J.K. Schaefer, K.D. GOODWIN, I.R. McDonald, J.C. Murrell, R.S. Oremland. *Leisingera methylohalidivorans* gen. nov., sp. nov., a marine methylotroph that grows on methyl

bromide. International Journal of Systematic and Evolutionary Microbiology 52:851-859, doi: 10.1099/ijs.0.01960-0 (2002).

35. R. Tokarczyk, K.D. GOODWIN, E.S. Saltzman. Methyl bromide loss rate constants in the North Pacific Ocean. Geophysical Research Letters 28(23):4429-4432, doi: 10.1029/2001GL013812 (2001).
36. K.D. GOODWIN, R.K. Varner, P.M. Crill, and R.S. Oremland. Consumption of tropospheric levels of methyl bromide by $C_1$ bacteria and comparison to saturation kinetics. Applied and Environmental Microbiology 67(12):5437-5443, doi: 10.1128/AEM.67.12.5437-5443.2001 (2001).
37. K.D. GOODWIN, J.K. Schaefer, and R.S. Oremland. Bacterial degradation of methyl bromide and dibromomethane in natural waters and enrichment cultures. Applied and Environmental Microbiology 64(12):4629-4636 (1998).
38. K.D. GOODWIN, W.J. North, M.E. Lidstrom. Production of bromoform and dibromomethane by Giant Kelp: factors affecting release and comparison to anthropogenic bromine sources. Limnology and Oceanography 42(8):1725-1734, doi: 10.4319/lo.1997.42.8.1725 (1997).
39. K.D. GOODWIN, M.E. Lidstrom, and R.S. Oremland. Marine bacterial degradation of brominated methanes. Environmental Science and Technology 31(11):3188-3192, doi: 0.1021/es970165g (1997).
40. S.L. Manley, K.D. GOODWIN, W.J. North. Laboratory production of bromoform, methylene bromide, and methyl iodide by macroalgae and distribution in near-shore southern California waters. Limnology and Oceanography 37(8):1652-1659, doi: 10.4319/lo.1992.37.8.1652 (1992).

**Other Publications**

Book Chapters

41. K.D. GOODWIN, F. Muller-Karger, G. Canonico. Molecular Approaches for an Operational Marine Biodiversity Observation Network. IN: World Seas: An Environmental Evaluation, Vol III. Ecological Issues and Environmental Impacts, 2nd edition. C. Sheppard, ed., Elsevier, in press (2018).
42. K.D. GOODWIN and R.W. Litaker. Emerging technologies for monitoring recreational waters for bacteria and viruses. IN: Oceans and Human Health: Risk and Remedies from the Seas. P.J. Walsh, S.L. Smith, W.H. Gerwick, H. Solo-Gabriele, L. Fleming, eds. Academic Press, New York, pp. 381-404, ISBN-13: 978-0123725844 (2008).
43. C.J. Palmer, T.D. Bonilla, J.A. Bonilla, S. Elmir, K.D. GOODWIN, H.M. Solo Gabriele, A. Abdelzaher. The future for monitoring. IN: Oceans and Human Health: Risk and Remedies from the Seas. P.J. Walsh, S.L. Smith, W.H. Gerwick, H. Solo-Gabriele, L. Fleming, eds. Academic Press, New York, pp. 405-429, ISBN-13: 978-0123725844 (2008).
44. K.D. GOODWIN, L. Matragano, D. Wanless, C. Sinigalliano, M.J. LaGier. The possibility of false negative results hampers the ability to elucidate the relationship between fecal indicator bacteria and human pathogens and source tracking markers in beach water and sand. IN: Marine Pollution: New Research. T.N. Hofer, ed. Nova Science Publishers, Inc., pp. 255-277, IBSN-13: 978-1604562422 (2008).

45. D. Voss, H. Maring, K.D. GOODWIN. Salt aerosol and bioaerosol production from a sea-salt aerosol generator. IN: Marine Pollution: New Research. T.N. Hofer, ed. Nova Science Publishers, Inc., pp. 399-429, IBSN-13: 978-1604562422 (2008).

Federal Reports

46. Interagency Strategic Plan for Microbiome Research FY2018-2022. April 2018. Microbiome Interagency Working Group (MIWG), an interagency working group under the Life Science Subcommittee (LSSC) of the National Science and Technology Council (NSTC) Committee on Science (CoS). https://science.energy.gov/~/media/ber/pdf/workshop%20reports/Interagency_Microbiome_Strategic_Plan_FY2018-2022.pdf

47. FTAC-MM. Report of the fast track action committee on mapping the microbiome. Product of the Life Sciences Subcommittee of the National Science and Technology Council. https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/NSTC/ftac-mm_report_final_112015_0.pdf (2015).

48. National Ocean Council. National Ocean Policy Implementation Plan. April 2013. https://obamawhitehouse.archives.gov/sites/default/files/national_ocean_policy_implementation_plan.pdf (2013).

49. T. Carsey, S. Stamates, N. Amornthammarong, J. Bishop, F. Bloetscher, C. Brown, J. Craynock, S. Cummings, W. Dammann, J. Davis, C. Featherstone, C. Fischer, K. GOODWIN, D. Meeroff, J. Proni, C. Sinigalliano, P. Swart, J.-Z. Zhang. Boynton Inlet 48-hour sampling intensives: June and September 2007. NOAA Technical Report, OAR AOML-40, 43 pp. (2012).

50. T. Carsey, C. Featherstone, K. GOODWIN, C. Sinigalliano, J. Stamates, J.-Z. Zhang, J. Proni, J. Bishop, C. Brown, M. Adler, P. Blackwelder, H. Alsayegh. Boynton-Delray Coastal Water Quality Monitoring Program. NOAA Technical Report, OAR AOML-39. (2011).

51. T.P. Carsey, H. Casanova, C. Drayer, C. Featherstone, C. Fischer, K. GOODWIN, J. Proni, A. Saied, C. Sinigalliano, J. Stamates, P. Swart, J.-Z. Zhang. FACE outfalls survey cruise - October 6-19, 2006. NOAA Technical Report, OAR-AOML-38 (2010).

52. T.P. Carsey, R. Ferry, K.D. GOODWIN, P.B. Ortner, J. Proni, P.K. Swart, J.-Z. Zhang. Brevard County Near Shore Ocean Nutrification Analysis. NOAA Technical Report, OAR AOML-37 (2005).

53. K.D. GOODWIN. The potential for biodegradation of trihalomethanes by aquifer bacteria. IN: M.S. Fram, B.A. Bergamaschi, K.D. GOODWIN, R. Fujii, J.F. Clark. Processes Affecting the Trihalomethane Concentrations Associated with the Third Injection, Storage, and Recovery Test at Lancaster, Antelope Valley, California, March 1998 through April 1999, U.S. Geological Survey Water-Resources Investigations Report, 03-4062, http://water.usgs.gov/pubs/wri/wri034062/ (2003).

54. M.S. Fram, J.K. Berghouse, B.A. Bergamaschi, R. Fuji, K.D. GOODWIN, and, J.F. Clark. Water-quality monitoring and studies of the formation and fate of trihalomethanes during the Third Injection, Storage, and Recovery Test at Lancaster, Antelope Valley, California, March 1998 through April 1999. U.S. Geological Survey Open-File Report 2002-102, https://pubs.er.usgs.gov/publication/ofr02102 (2002).

Non-Federal Reports

55. Assessment of Ichthyoplankton Metabarcoding for Routine Monitoring. D. Kacev, D. Gillett, A. Freire de Carvalho, C. Cash, S. Walther, C.D. Larsen, A. Thompson, L. Thompson, N. Bowlin, K. Goodwin, E.D. Stein. Southern California Coastal Water Research Project (SCCWRP) Technical Report 1031 (2018).

56. Southern California Bight 2013 Regional Monitoring Program: Volume IX. Shoreline Microbiology. Y. Cao M.R. Raith, P.D. Smith, J.F. Griffith, S.B. Weisberg, A. Schriewer, A. Sheldon, C. Crompton, G.G. Amenu, J. Gregory, J. Guzman, K.D. GOODWIN, L. Othman, M. Manasjan, S. Choi, S. Rapaport, S. Steele, T. Nguyen, X. Yu. Southern California Coastal Water Research Project (SCCWRP) Technical Report 1005 (2017).

57. Los Angeles Harbor Inner Cabrillo Beach Bacteria Total Maximum Daily Load (TMDL) Implementation and Natural Source Exclusion (NSE) Program: Exceedance Filters Part II. Weston Solutions, Inc. for the Port of Los Angeles. August (2017).

58. Los Angeles Harbor Inner Cabrillo Beach Bacteria Total Maximum Daily Load (TMDL) Implementation and Natural Source Exclusion (NSE) Program: Phase III, Special Studies Summary Report. Weston Solutions, Inc. for the Port of Los Angeles. November (2016).

59. Los Angeles Harbor Inner Cabrillo Beach Bacteria Total Maximum Daily Load (TMDL) Implementation and Natural Source Exclusion (NSE) Programs: 2014-2015 Microbial Source Tracking (MST) with Integrated Analysis (2012-2015). Weston Solutions, Inc. for the Port of Los Angeles. September (2015).

60. Los Angeles Harbor Inner Cabrillo Beach Bacteria Total Maximum Daily Load (TMDL) Implementation and Natural Source Exclusion (NSE) Programs: Overall Work Plan Version 3.0. Weston Solutions, Inc. for the Port of Los Angeles. July (2015).

61. 2013 Annual Report Southern California Coastal Water Research Project (SCCWRP). Evaluation of the repeatability and reproducibility of a suite of qPCR-based microbial source tracking methods, D.L. Ebentier, K.T. Hanley, Y. Cao, B.D. Badgley, A.B. Boehm, J.S. Ervin, K.D. GOODWIN, et al., pp. 433-444 (2013).

62. 2013 Annual Report Southern California Coastal Water Research Project (SCCWRP). Multi-laboratory evaluations of the performance of *Catellicoccus marimammalium* PCR assays developed to target gull fecal sources. C.D. Sinigalliano, J. Ervin, L.C. Van De Werfhorst, B,D Badgley, E. Ballesté, J. Bartkowiak, A.B. Boehm, M. Byappanahalli, K.D. GOODWIN, et al., pp. 523-539 (2013).

63. 2013 Annual Report Southern California Coastal Water Research Project (SCCWRP). Performance evaluation of canine-associated Bacteroidales assays in a multi-laboratory comparison study. A. Schriewer, K.D. GOODWIN, et al., pp. 540-553 (2013).

64. 2013 Annual Report Southern California Coastal Water Research Project (SCCWRP). Recommendations following a multi-laboratory comparison of microbial source tracking methods. J.R. Stewart, A.B. Boehm, E.A. Dubinsky, T-T. Fong, K.D. GOODWIN, J.F. Griffith, R.T. Noble, O.C. Shanks, K.Vijayavel, S.B. Weisberg, pp. 581-593 (2013).

65. Inner Cabrillo Beach 2012-2013 Source Identification Surveys. Weston Solutions, Inc. for the Port of Los Angeles. August (2013).

66. Inner Cabrillo Beach Natural Source Exclusion Eligibility Study, Study Outline for Winter 2013 Mini-Study. Weston Solutions, Inc. for the Port of Los Angeles. January (2013).

67. Inner Cabrillo Beach Natural Source Exclusion Mini-Studies, Summer 2012. Weston Solutions, Inc. for the Port of Los Angeles. December (2012).

68. Los Angeles Harbor Inner Cabrillo Beach TMDL Implementation and Natural Source Exclusion Work Plan Version 2.0. Weston Solutions, Inc. for the Port of Los Angeles. May (2012).

69. Los Angeles Harbor Inner Cabrillo Beach TMDL Implementation and Natural Source Exclusion Workplan Draft Annotated Framework. Weston Solutions, Inc. for the Port of Los Angeles. April (2012).

70. 2012 Annual Report Southern California Coastal Water Research Project (SCCWRP). K.D. GOODWIN, M. McNay, Y, Cao, D. Ebentier, M. Madison, J.F. Griffith. A multi-beach study of *Staphylococcus aureus*, MRSA, and enterococci in seawater and beach sand. pp. 357-373 (2012).

71. Tijuana River Bacterial Source Identification Study Final Report. Weston Solutions, Inc. for the City of Imperial Beach (2012).

72. 2009 Annual Report Southern California Coastal Water Research Project (SCCWRP). A.B. Boehm, J. Griffith, C. McGee, T.A. Edge, H.M. Solo-Gabriele, R. Whitman, Y. Cao, M. Getrich, J.A. Jay, D. Ferguson, K.D. GOODWIN, C.M. Lee, M. Madison, S.B. Weisberg. Fecal indicator bacteria (FIB) enumeration in beach sand: A comparison study of FIB extraction methods in medium to coarse sands. pp. 249-261 (2009).

73. Final Report: An Investigation of the South Central Regional Wastewater Treatment Plant Ocean Outfall and Coastal Environment. J. Proni, M. Adler, N. Amornthammarong, J. Bishop, F. Bloetscher, T. Carsey, J. Craynock, S. Cummings, P. Dammann, C. Drayer, C. Featherstone, D. Meerhoff, K .GOODWIN, E. Peltola, D. Pierrot, C. Sinigalliano, P. Swart, J. Stamates, K Sullivan, R. Wanninkhof, J-Z Zhang (2009).

<u>Conference Proceedings</u>

74. A glimpse of the Florida Area Coastal Environment (FACE) program. T. Carsey, K.D. GOODWIN, J. Hendee, J.R. Proni, C. Sinigalliano, J. Stewart, J-Z. Zhang, N. Amornthammarong, J. Craynock, S. Cummings, P. Dammann, C. Featherstone, J. Stamates, K. Sullivan. Proceedings of the 11$^{th}$ International Coral Reef Symposium, Ft. Lauderdale, Florida, 7-11 July 2008, Session number 16, Vol. 1:566-570 (2009).

75. Genetic sensors for environmental water quality, Alliance for Coastal Technologies, Workshop Proceedings, St. Petersburg, FL, January 5-7, 2005. Ref. No. [UMCES]CBL 05-069. (2005).

76. Detection of *Karenia brevis* by a microtiter plate assay. K.D. GOODWIN, G. Scorzetti, S.A. Cotton, T.L. Kiesling, P.B. Ortner, J.W. Fell. IN: Harmful Algae 2002. Proceedings of the 10th International Conference on Harmful Algae. K.A. Steidinger, J.H. Landsberg, C.R. Tomas, G.A. Vargo, G.A. (Eds.). Florida Fish and Wildlife Conservation Commission, Florida Institute of Oceanography and Intergovernmental Oceanographic Commission of UNESCO: Paris (2004).

Thesis

77. K.D. GOODWIN. Natural cycles of brominated methanes: macroalgal production and marine microbial degradation of bromoform and dibromomethane. Ph.D. thesis, California Institute of Technology, http://resolver.caltech.edu/CaltechETD:etd-12142007-081155 (1996).

## Development Accomplishments

### Advances in Technology

**Improving Operations through Metabarcoding and eDNA** 2018- present

Omics can improve NOAA's operational efficiency resulting in reduced operating costs and increased public access to data. This work focuses on molecular methods and technologies that reduce sample backlog, environmental impact, and costs compared to conventional sampling and sample processing methods. Components include development of metabarcoding to replace manual sorting and visual identification of larval fish and eggs; using environmental DNA (eDNA) to provide information about commercially important and protected species without the need to process tissues or trawl through sensitive habitats.

**Develop mobile sensors and platforms for management and decision support** 2016- present

Accelerated transition of unmanned genomic sampling by field testing a long-range autonomous underwater vehicle (LRAUV) prototype in the California Current in coordination with NOAA ship operations and in the Great Lakes in coordination with boat operations and *in situ* platforms.. Furthered environmental DNA (eDNA) research and qPCR techniques to improve ecosystem state assessment, minimize environmental impacts, and control operational costs. Maximized leverage by facilitating cross-line NOAA coordination (OAR, NOS, and NMFS) and collaboration with Monterey Bay Aquarium Research Institute (MBARI).

**Foster bioinformatics workforce and computing capacity** 2016- present

Extended NOAA bioinformatics capacity by developing, promoting, and implementing programmatic support for young scientists, directing projects, and facilitating coordination across NOAA line offices and with Big Data CRADA partners.

**Integrate 'omic technologies into assessment programs** 2014-present

Helped achieve integration of routine genetic analysis into the California Cooperative Oceanic Fisheries Investigations (CalCOFI), the world's longest running fisheries and ecosystem observing program. Metagenomic and metatranscriptomic analysis performed in collaboration with academic and private partners, including the JC Craig Venter Institute to improve the quality and scope of "environmental intelligence" gathered by NOAA. Lead research efforts to transition data into ecosystem models and status reports.

**Genetic assays and sensors to monitor coastal waters for biological threats** 1995-2015

Directed multiple projects to develop assays and sensors to detect genetic signatures of fecal contamination, harmful microbes, and toxic algae in ambient waters. Technology examples include electrochemical assays, Luminex platform (bead array detection), Synchronous Coefficient of Drag Alteration (SCODA) nucleic purification, and qPCR. Worked in collaboration with multiple industrial and academic partners.

## Programs Planned, Formulated and Managed

**AOML ´Omics Program** 2016-2018

Genetic information is studied to understand how marine organisms and ecosystems can remain healthy and productive, with benefits to jobs and economies that depend on ecosystem services, such fisheries and tourism. This program is multidisciplinary, cross-line (OAR, NMFS, NOS), and collaborative with several institutes (U Miami, U Florida, U South Florida, U Southern Mississippi, U California San Diego, Monterrey Bay Research Institute, JC Venter Institute). The science portfolio includes:

- Construction and operation of the Experimental Reef Laboratory, an experimental aquarium that can finely manipulate ecosystem stress to identify genes that allow some corals to resist bleaching and disease; more resilient corals can be used to restock reefs and provide ecosystem recovery.
- Determine biodiversity in coral systems by metagenomic characterization of microbiome samples taken from corals and coral sediments; trends in biodiversity are a proxy of ecosystem function.
- Analytical improvement through ichthyoplankton metabarcoding to increase efficiency and reduce costs by supplanting manual sorting and visual identification, which is labor-intensive and slow.
- Scientific innovation through eDNA to assess higher trophic levels (fish, turtles) from filtered seawater via capture of sloughed or excreted cells so that samples can be collected without animal capture, tissue processing, or trawling through sensitive habitats.
- Field tests of an emerging technology that couples autonomous underwater vehicle (AUV) sample collection with DNA analysis to combat rising ship-time costs.
- Genetics to differentiate Florida Bay Spotted Seatrout to determine whether saline tolerances affect population structure in order to characterize long term impacts of freshwater flow and inform future watershed management.
- Engagement of fisheries biologists and modelers with ´omic experts to develop environmental indices; facilitate research-to-application success by integrating the new indices into models to assess economically important fish species and into recruitment models of endangered species.
- Bioinformatics, IT enhancement, and workforce development. Supports a number of young scientists, mid-career staff, student workers (n~11), and the science of a variety of federal Principal Investigators. This program helps address a critical gap in bioinformatics expertise to ease the bottleneck in data analysis and interpretation.

## Projects Planned, Formulated and Managed (*selected, additional to development & transition*)

**Comparative metagenomics to indicate sites under anthropogenic pressure**. Bioinformatic analysis of samples collected during Ocean Sampling Day and from the Gulf of Mexico water column prior to the Deep Water Horizon to develop usage of high-throughput sequencing in ecosystem status analysis.

**Exploration of deep-sea biodiversity**. Analysis of the genome and gut microbiome of a rare invertebrate that survives on transient methane clathrate ("methane ice") to reveal extreme environment metabolic strategies.

**Detection of microbial contaminants for safe-to-swim applications**. Enumeration of the dermal pathogen *Staphylococcus aureus* and determination of antibiotic resistance in beach water and

sand with comparison to indicators used to regulate public beach access for multiple large-scale studies including: 1) the Pacific Coast Water Epidemiology Study (226 sampling events); 2) The 50 beach study (77 sampling events); 3) the Oahu Streams Study (55 sampling events).

**Analysis of coastal waters receiving treated wastewater**. Microbiology for the Florida Area Coastal Environment (FACE) Project including traditional and molecular analysis of fecal indicators (enterococci, *Escherichia coli*, *Bacteroides* spp.), source tracking markers (human, dog, gull), pathogens (*Staphylococcus aureus*, MRSA, *E. coli* O157:H7, *Campylobacter jejuni*, *Salmonella* spp., adenovirus, *Cryptosporidium*/*Giardia*, *Vibrio*), harmful algae (*Karenia brevis*, *K. mikimotoi*).

**Bacterial pathogens detected by marine mammal remote biopsy**. Pilot study of ability to detect bacterial pathogens from remote biopsy samples taken from free-ranging coastal dolphins.

**Biodegradation of carbon tetrachloride**. Flux chamber measurements demonstrated ubiquitous nature of CCl4 uptake by soils with demonstration of biological uptake (versus abiotic).

**Microbial biogeochemistry of C-1 halocarbons**. Magnitude, kinetics, and mechanisms of biodegradation of ozone-depleting gases in aquatic systems in order to understand the impact of microbial processes on global halocarbon cycles. Novel bacterial isolates identified and characterized. Includes GenBank submission of 16S ribosomal RNA gene sequence for Sphingomonadaceae bacterium Oxy6.

**Others** (*NOAA external projects*)

Visiting Research Fellow, Environmental molecular microbiology Department of Biological Sciences, University of Warwick, Coventry, UK Oct. – Nov. 2000

Identified and began sequencing a gene involved in methyl bromide metabolism by a marine bacterium. Approaches included protein gel analysis, southern blotting, and direct PCR amplification using primers designed from potentially homologous functional genes.

United States Geological Survey, Menlo Park, CA Sept. 1995 – Dec.1998

Quantified bacterial sinks of halocarbons in freshwater, estuarine, marine, and hypersaline environments and evaluated the environmental significance of these sinks. Characterized bacteria responsible for halocarbon degradation in environmental samples. Implemented a technique to separate radioisotopes for analysis by liquid scintillation spectrophotometry. Coordinated work between USGS offices in Menlo Park and Sacramento in order to satisfy research needs of local and regional water agencies. Determined the potential for trihalomethane biodegradation in an aquifer so that water used in an artificial storage and recovery project (ASR) will meet present and future EPA regulations.

California Institute of Technology, Pasadena, CA 1989 – 1995

Quantified natural sources and sinks in the global bromine cycle and compared to anthropogenic inputs in order to evaluate the impact of ozone-depleting chemicals. Utilized knowledge of macroalgal biology and ecology, microbiology, water and atmospheric chemistry, hydrology, and sea-air exchange.

## Transitions of Research to Applications

**R2C, Cooperative Research and Development Agreement (CRADA)** 2012-2017

Achieved research-to-commercial (R2C) technology transfer of rapid diagnostic methods and microbial source tracking assays (MST) to commercial usage by Weston Solutions, Inc. Carlsbad, CA.

- Established commercial molecular biology laboratory. Authored and implemented suite of Standard Operating Procedures, including Quality Control/Quality Assurance procedures. Trained personnel to perform laboratory analyses. Trained clients in sample collection for molecular analysis, including production of video instruction.
- Transition evidenced by ability to purchase assay services, peer-reviewed publications, "success story" film by NOAA's technology transfer office, and feature in the Technology Transfer Summary Report for NOAA, December 2016, pp. 25-26.
- Recipient of the 2012 NOAA Technology Transfer Award for "*exceptional leadership in developing and transferring Microbial Source Tracking tools to identify coastal waters contamination sources and allowing city and county managers to devise mitigation strategies to restore water quality, decrease risks to human health, and preserve coastal economies*."

**R2A, Transition to coastal water and watershed quality management applications** 2011-2017

Achieved research-to-application (R2A) transition.

- Transition to stakeholders evidenced by NOAA-AOML protocols being included in the California Microbial Source Identification Manual (SCCWRP Technical Report 804, 2013) by meeting performance metrics set in an international inter-lab validation effort. http://www.swrcb.ca.gov/water_issues/programs/beaches/cbi_projects/docs/sipp_manual.pdf
- Transition to regional monitoring programs evidenced by peer review manuscript (Cao et al., 2017) that demonstrated the benefit of utilizing microbial source tracking (MST) as a routine water quality monitoring tool. Transitions were facilitated by participation in committees that created standardized protocols to facilitate technology transfer to regional stakeholders.
- Transferred molecular techniques developed by NOAA/AOML to implement and evaluate Best Management Practices (BMPs), Total Maximum Daily Loads (TMDLs), Quantitative Microbial Risk Assessments (QMRA), and Natural Source Exclusion (NSE) applications. Projects planned, conducted, or contributed directly include (but not limited to):
    - Cabrillo Beach Quantitative Microbial Risk Assessment, City of Los Angeles, CA
    - Cabrillo Beach Bacterial Source Identification Investigation, City of Los Angeles, CA
    - Tijuana River Bacterial Source Identification Study, City of Imperial Beach, CA
    - Poche Beach Bacterial Source Identification Investigation, City of San Clemente, CA
    - Molecular Source Tracking Services for the County of Ventura, CA Watershed Protection District
    - Bacterial Identification Study, Lambert Creek, MN
    - Microbial Source Identification Study for Buccaneer Beach and Loma Alta Creek in Oceanside, CA

  The above projects are some of the contributions to the AOML performance measure "the cumulative number of partners/customers/contracts that deployed molecular and microbial

assays for measuring and tracking microbial pollution in coastal ecosystems, including recreational waters", which is tracked in the Annual Operating Plan.

**Biosensor development and transfer for microbial contaminant monitoring** 2004-2010

Led projects to develop improved methods of nucleic acid extraction to help improve automated and in-situ biosensing in marine waters. Directed multiple projects to develop rapid assays for molecular water quality analysis, including development of a quantitative assay for dog fecal source identification. Evidence of progress included:

- negotiated intellectual property and non-disclosure agreements with industrial partners (Alderon Biosciences).
- produced engineering scheme of full microfluidic integration into commercially available Alderon electrochemical instrumentation, and produced three iterations of a prototype flow cell/ DNA amplification chip.
- completed market analysis of two DNA hybridization techniques (microplate and Luminex) in collaboration with RTI, experts in technology transfer.
- utilization of electrochemical and colorimetric assays to detect harmful algae in Rookery Bay National Estuarine Research Reserve samples.
- establishment of a technology transfer web portal: How to Perform the Microplate Assay, A Molecular Diagnostic Technique (2006; http://ciceet.unh.edu/project_extras/microplate_assay/)

**Protocol sharing and implementation of inter-laboratory testing** 2008

Led efforts to optimize a diagnostic assay for fecal contamination from dogs, transferred protocol to community of Northern Gulf Cooperative Institute (NGCI) researchers, and participated in round-robin testing with partnering laboratories.

## Professional Development

2017 Data Carpentry for Ecology, Ottawa, Ontario, Canada
2017 R programming
2017 Introduction to Git and GitHub
2017 Introduction to Project Risk Management using @RISK
2017 Introduction to R for Oceanographers
2016 Shotgun Metagenome Analysis Workshop
2014 Sequencing Technology Education Using Microbial Metagenomes Faculty Workshop
2013 R programming
2012 EU-US Theoretical and Practical Training Course, Marine Bioinformatics "Marine Omics", Jacobs University, Bremen, Germany
2011 Quantitative Microbial Risk Assessment Workshop, Water Quality and Technology
2011 Real-Time Quantitative PCR Workshop, Water Quality and Technology
2010 Marine Mammal Stranding and Necropsy Training
2005 Quantitative PCR (Bio-Rad), Florida International University
2004 Microbial Source Tracking Using Indicator Organisms, American Society for Microbiology
2003 Prokaryotic Annotation and Analysis, The Institute for Genomic Research (TIGR)
2000 Visiting Research Fellow, University of Warwick, Coventry, United Kingdom
2000 New England Biolabs Workshop in Molecular Biology and Polymerase Chain Reaction (PCR)

# Presentations

## Published Abstracts

L. Thompson, K. Harper, K. GOODWIN. Computational workflows for rapid and customizable analysis of amplicon sequencing data from environmental DNA. 48th Annual Meeting of the American Fisheries Society (AFS) Atlantic City, New Jersey August 20 (2018).

K. Yamahara, C. Preston, R. Marin III, D. Pargett, S. Jensen, B. Roman, J. Birch, K. Van Houtan, F. Chavez, K. GOODWIN, C. Scholin. Autonomous eDNA Sampling: Development and Application of eDNA Methods on the 3rd Generation Environmental Sample Processor. 48th Annual Meeting of the American Fisheries Society (AFS) Atlantic City, New Jersey August 21 (2018).

L. Zeigler Allen, A. Rabines, J.P. McCrow, H. Zheng, K. GOODWIN, M. L. Bohan, A.E. Allen. Exploring 'omic technologies to support ecosystem understanding and fisheries assessments. CalCOFI Conference, December 6 (2017).

D. Kacev, L. Thompson, K. GOODWIN, E. Stein, D. Gillette, A. Freire, A. Thompson. Developing a robust framework for applying metabarcoding analyses to identify pelagic ichthyoplankton. CalCOFI Conference, December 6 (2017).

K.D. GOODWIN, F.E. Muller-Karger, G. Canonico. Integrating marine omics into the marine biodiversity observation network (MBON) in support of the U.N. sustainable development goals (SDG) and agenda 2030. Proceedings of TDWG 1: e2052, doi: 10.3897/tdwgproceedings.1.20521, October 2 (2017).

K.D. GOODWIN, L. Zeigler Allen, A. Rabines, J. McCrow, A. Allen. Inclusion of DNA sequencing into an ecosystem observing program in the southern California Bight. ICES CM 2017/C. International Council for the Exploration of the Sea 2017 Annual Science Conference 18-21 September (2017).

L. Zeigler Allen, A. Rabines, J. McCrow, K. GOODWIN, A. Allen, Pelagic microbial linkages in the southern California Current Ecosystem, 29976, American Society of Limnology and Oceanography, February 26-March 3 (2017).

K. GOODWIN. Challenges in method calibration. 2016 Proceedings of the National Environmental Monitoring Conference (NEMC), Applications of Quantitative Polymerase Chain Reaction (qPCR) Methods for Microbiological Contaminants, Friday August 12 (2016). **INVITED**

K. GOODWIN, G. Doucette, T. Davis, S. Moore, and L. Rhodes. 3G ESP/LRAUV Mobile ´omics and toxin detection platform (building on success of the 2G technology). Report from the NOAA Emerging Technologies Workshop for Observations, prepared by Technology, Planning and Integration for Observation, July 27 (2016).

A. Jirik, A. Crumpacker, A. Schriewer, K. GOODWIN. Steps towards bacteria TMDL compliance: The proposed Inner Cabrillo Beach Natural Source Exclusion. California Stormwater Quality Association (CASQA) October 20 (2015).

A.E. Allen, K. GOODWIN, R. Goericke, M. Bohan, S. Dovel, A. Rabines, M. Roadman, H. Zheng, D. Checkley. Influence of nutrients and temperature on pelagic ecosystem microbial networks in the southern California Current ecosystem. CalCOFI Conference December 14-16 (2015).

S. Gruber, K. GOODWIN, M. Vondrak, A. Crumpacker, Bacterial source identification at Poche Beach – An integrated approach to improving beach water quality and meeting TMDL

compliance targets. California Stormwater Quality Association (CASQA), September 15-17 (2014).

N. Valette-Silver, K. GOODWIN, R. Paranjpye, M. Delorenzo, J. Jacobs. NOAA's participation in the International Ocean Sampling Day. Ocean Sciences Meeting (ASLO/AGU), Abstract ID: 18050, February 23-28 (2014).

B.A. Layton, K.M. Yamahara, A.M. Cox, K.D. GOODWIN, W. Nilsson, M. Strom, C.A. Scholin, J.F. Griffith. Inter-laboratory calibration study of *in situ* automated qPCR for *Enterococcus* versus commercial bench-top instruments. American Society of Microbiology, May 17-24 (2014).

K.D. GOODWIN, L. Edsall, W. Xin, S.R Head, L. Katz, A.M. Wood, T. Gaasterland. Metagenomics of the methane ice worm, *Hesiocaeca methanicola*, and associated microbes, Abstract OS13C-1753 presented at 2012 Fall Meeting, AGU, San Francisco, CA, December 3-7 (2012).

A.M. Wood, K.D. GOODWIN, D. Brami, A. Schwartz, G. Toledo. Metagenomics of water column microbes near brine pool NR1 and adjacent regions of the Northern Gulf of Mexico collected in Fall 2009, Abstract OS13C-1755 presented at 2012 Fall Meeting, AGU, San Francisco, CA, December 3-7 (2012).

K.D. GOODWIN, K. Yamahara, A. Cox, B. Nilsson, B. Layton, A. Boehm, J. Griffith, M. Strom, S. Weisberg, C. Preston, C. Scholin, and Spyglass Inc. In-situ biological sensors for public health risk detection in coastal waters. 92$^{ND}$ American Meteorological Society Annual Meeting, Environment and Health Symposium, New Orleans, LA, January 24 (2012). **INVITED**

K.D. GOODWIN. The New Bacteria Toolbox: Rapid response, source ID, remediation, and site-specific criteria. California Stormwater Quality Association (CASQA), November 5 (2012).

K.D. GOODWIN. The need to improve sample preparation to advance sensing of microbial contaminants in marine environments. Sample Prep 2011, Knowledge Foundation 4th Annual Detection Technology Conference, Sample Preparation for Virus, Toxin & pathogen Detection & Identification. San Diego, CA, April 5 (2011). **INVITED**

K.D. GOODWIN, M. Pobuda, Y. Cao, M. Madison, D. Ebentier, S.B. Weisberg. A multi-summer study of *Staphylococcus aureus* and MRSA in the water and sand of three southern California beaches. USEPA National Beaches Conference. Miami, FL, March 15-17 (2011).

K. Yamahara, L.M. Sassoubre, K.D. GOODWIN, A.B. Boehm. Occurrence and persistence of human pathogens and indicator in beach sands along the California coast. USEPA National Beaches Conference. Miami, FL, March 15-17 (2011).

K.D. GOODWIN, M. Pobuda, J. Griffith, M. Madison, D. Ebentier, Y. Cao, S. Weisberg. Detection of *Staphylococcus aureus* and MRSA in beach water and sand & the performance of ChromAgar media for enumeration of environmental samples. Eos Trans. AGU, 91(26), Ocean Sci. Meet. Suppl., Abstract IT31B-07 (2010).

E. J. Viau, K. Y. Yamahara, K. D. GOODWIN, and A. B. Boehm. An assessment of fecal indicator and pathogen concentrations in 22 Hawaiian coastal streams. Microorganisms in marine environments and shellfish, American Society of Microbiology, San Diego, CA. May 25 (2010).

C. Sinigalliano, D. Wanless, M. Gidley, T. Scott, and K. GOODWIN. Microbial water quality of treated wastewater outfalls, American Society of Microbiology, San Diego, CA. May 25 (2010).

M. Gidley, D. Wanless, T. Shibata, M. Wright, J. Kish, S. Elmir, A. Abdelzaher, K. GOODWIN, H. Solo-Gabriele, L. Fleming, C. Sinigalliano. Preliminary assessment and methods comparison for relative abundance of enterococci and Bacteroides at a South Florida recreational beach. Abstracts of the American Society for Microbiology, 109th General Meeting, Pennsylvania Convention Center, May 17-21, 2009. Abstract Number: Q-447 (2009).

J. Bartkowiak, D. Wanless, K. GOODWIN, C. Sinigalliano. Analysis of environmental sample DNA Extraction efficiency for quantitative real-time PCR of fecal indicator bacteria using a commercial DNA binding matrix purification procedure. American Society for Microbiology General Meeting, Philadelphia, PA, May 17-21 (2009).

K.D. GOODWIN, W. Litaker, D. Fries. Emerging detection methods for microbial contaminants and HAB toxins. National Beaches Conference, Huntington Beach, CA, April 20-22 (2009). **INVITED**

K.D. GOODWIN. Emerging technologies for public health applications of coastal observing systems. 120: Oceans and Human Health: Identifying and Understanding Ocean Health Benefits and Threats. American Society for Limnology and Oceanography, Orlando, FL, March 2-7, 2008, Abstract ID:1327 (2008).

C Sinigalliano, D. Wanless, M. Gidley, T. Scott, J. Stewart, D. Meeroff, F. Bloetscher, J. Boyer, and K. GOODWIN. Molecular microbial water quality assessment and bacterial source tracking for the Florida Area Coastal Environment (FACE) Program. 120: Oceans and Human Health: Identifying and Understanding Ocean Health Benefits and Threats. American Society for Limnology and Oceanography, Orlando, FL, March 2-7, 2008, Abstract ID:2151 (2008).

K.D. GOODWIN, D. Wanless, and J. Fell. Luminex detection of fecal indicators and source tracking markers in coastal waters and beach sand. Biodetection 2007, San Diego, CA, November 1, 2007.

M.J. LaGier, A. Farmer, K.D. GOODWIN. Development of electrochemical biosensors for detection of microbial contaminants in coastal waters. CS17, Molecular Techniques and Perspectives. Annual Meeting of the American Society of Limnology and Oceanography, Santa Fe, New Mexico, February 4-7 (2007).

K.D. GOODWIN, C. Garcia, J.A. Bonilla, T.D. Bonilla, D. Wanless, A. Abdelzaher, M.J. LaGier, H. Solo-Gabriele. Concentration and extraction: efforts to overcome issues with processing coastal water samples for downstream molecular analysis. Proceedings of the Annual Meeting of the Florida Branch of the American Society for Microbiology, March 31-April 1 (2006).

M. Ortiz and K.D. GOODWIN. Molecular methods development for coastal water quality. Annual Biomedical Research Conference for Minority Students (ABRCMS). Abstract #1185. Anaheim, CA, November 8-11 (2006).

M.J. LaGier, A. Farmer, K.D. GOODWIN. Developing portable electrochemical biosensors for monitoring microbial water quality. National Beaches Conference. Niagara Falls, NY, October 11-13 (2006).

A.M. Abdelzaher., M. E. Durbin, K.D GOODWIN, J.A. Bonilla, H.M. Solo-Gabriele, T.D., Lam, C. Block, C. Garcia, A. Sardeshmukh, S. Elmir, G. Miller, P. Shih,E. Quaye, J. Cooper, C. Sinigalliano, C.J. Palmer. Evaluation of two concentration methods for detection of pathogens in spiked ocean water samples. Proceedings of the 106th General Meeting of the American Society for Microbiology. Abstract number Q-244 (2006).

H.M. Solo-Gabriele, J.D. Wang, L. Fleming, E. Elmir, K. GOODWIN, J.M. Fleisher, L. Backer, C.J. Palmer, P. Minnett, C. Sinigalliano, J. Fell and E. Rankey. Assessment of microbial indicators for monitoring recreational water quality in marine subtropical environments. Proceedings of the Joint Meeting for the NOAA, NSF/NIEHS Centers for Oceans and Human Health (OHH), p. 39, Seattle, WA, April 24-25 (2006).

K.D. GOODWIN. Adaptation of the Luminex 100 System to use in recreational waters. Clean Beaches Council. Proceedings of the Sustainable Beaches Conference ’05, St. Petersburg, FL, Oct. 31-Nov. 2 (2005).

M.E. Durbin, A.M. Zaher, N.F. Heybeck, H.M. Solo-Gabriele, S. Elmir, K.D. GOODWIN, C. Sinigalliano. The source of enterococci to a subtropical recreational beach is the inter-tidal zone. Proceedings of the Annual Meeting of the Florida Branch of the American Society for Microbiology (2005).

M.J. LaGier, J.W. Fell, and K.D. GOODWIN. Portable Electrochemical Biosensors for Detecting of Marine Microorganisms. Proceedings of the Annual Meeting of the Florida Branch of the American Society for Microbiology (2005).

H.M. Solo-Gabriele, M.E. Durbin, A.M. Abdelzaher, N.F. Heybeck, S. Elmir, K.D. GOODWIN, K.D., C. Sinigalliano. Factors that influence fecal indicator microbe levels. Proceedings of the Annual Meeting of the Florida Branch of the American Society for Microbiology (2005).

I.B. Baums, T. Kiesling, K.D. GOODWIN, and J.W. Fell. Detection of fecal indicators in recreational waters using the Luminex 100 System. TS31, Water Quality Research in the 21st Century: Global Climate to Genomics. American Society of Limnology and Oceanography Aquatic Sciences Meeting, Salt Lake City, UT, February 20-25 (2005).

M.J. LaGier, J.W. Fell, and K.D. GOODWIN. Electrochemical biosensors for use with coastal waters. Clean Beaches Council. Proceedings of the Sustainable Beaches Conference ’05, St. Petersburg, FL, Oct. 31-Nov. 2 (2005).

J.D. Wang, H. Solo-Gabriele, M. Durbin, A. Zaher, L. Fleming, I. Baums, S. Elmir, J. Fleisher, K. GOODWIN. Microbial indicators and pathogens in a subtropical non-point source environment. Clean Beaches Council. Proceedings of the Sustainable Beaches Conference ’05, St. Petersburg, FL, Oct. 31-Nov. 2 (2005).

H.M. Solo-Gabriele, M.E. Durbin, A.M. Abdelzaher, N.F. Heybeck, J.D. Wang, S. Elmir, K.D. GOODWIN, C. Sinigalliano. Beach microbial indicators and pathogens in a subtropical non-point source environment. Clean Beaches Council. Proceedings of the Sustainable Beaches Conference ’05, St. Petersburg, FL, Oct. 31-Nov. 2 (2005).

M.E. Durbin, A.M. Zaher, N.F. Heybeck, H.M. Solo-Gabriele, S. Elmir, K.D. GOODWIN, C. Sinigalliano. The inter-tidal zone is the source of enterococci to a subtropical recreational beach. Proceedings of the 105th General Meeting of the American Society for Microbiology. Abstract number Q-322 (2005).

S. Yvon-Lewis, K. GOODWIN, K.,S. Cotton,, J. Butler, D. King., E. Saltzman, R. Tokarczyk, P. Matrai, B. Yocis, E. Loiseau. G. Sturrock. NOAA and university scientists study methyl bromide cycling in the North Pacific. Water Encyclopedia. 4:80–81, J. Wiley & Sons, Inc. (2005).

K.D. GOODWIN. Assay and Remote Sensor Development for Molecular Biological Water Quality Monitoring. Proceedings of the 2004 National Beaches Conference, October 13-15, 2004, San Diego, EPA-823-R-05-001, March (2005).

K.D. GOODWIN, S.A. Cotton, G. Scorzetti, T.L. Kiesling, J.W. Fell. Immobilized DNA probes to rapidly detect toxic dinoflagellates and sewage-indicating bacteria. Proceedings of the 2004 National Beaches Conference, October 13-15, 2004, San Diego, EPA-823-R-05-001 March (2005).

T.L. Kiesling, M. Diaz, K.D. GOODWIN, S.A. Cotton, J.W. Fell. Hybridization based detection of fecal bacteria using the Luminex 100 System. Proceedings of the 2004 National Beaches Conference, EPA-823-R-05-001, March (2005).

M.J. LaGier, M. Diaz, K.D. GOODWIN, J.W. Fell. Electrochemical detection of DNA: applications in diagnostic mycology. The 11th International Congress on Yeasts (ICY 2004), Rio de Janeiro, Brazil, 15-20, August 2004, FEMS Yeast Research, 5:485–489 (2004).

T.L. Kiesling, M. Diaz, K.D. GOODWIN, S.A. Cotton, J.W. Fell. Hybridization based detection of fecal bacteria using the Luminex 100 System. SS9.06, Dynamics of Pathogens in Marine Systems, American Society of Limnology and Oceanography, Honolulu, HI, February 15-20 (2004).

L.G. Miller and K.D. GOODWIN. Forward. Biogeochemistry 60(2):119-120. IN: Halocarbon Biogeochemistry, special issue of Biogeochemistry, L.G. Miller and K.D. GOODWIN, editors, 92 pages (2002).

K.D. GOODWIN, G. Scorzetti, S. Cotton, J. Fell, Microplate detection of microorganisms that indicate coastal water quality. Eos Trans. AGU, 83(47), Fall Meet. Suppl., Abstract OS21B-0215 (2002).

R. Tokarczyk, K.D. GOODWIN, E.S. Saltzman. Methyl bromide and methyl chloride degradation in the Southern ocean. Eos Trans. AGU, 83(47), Fall Meet. Suppl., Abstract A72C-0182 (2002).

K.D. GOODWIN. G. Scorzetti, S.A. Cotton, T.L. Kiesling, P.B. Ortner, J.W. Fell. Well-plate assay detection of toxic dinoflagellates. Xth International Conference on Harmful Algae, Sarasota, FL. October 21-25 (2002).

E. Borodina, I.R. McDonald, K.D. GOODWIN, J.C. Murrell. Molecular ecology of methyl halide degradation. The Gordon Research Conference, Molecular Basis of Microbial One-Carbon Metabolism, New London, CT, July 7-12 (2002).

K.D. GOODWIN, F.C. Stephens, R. Tokarczyk, E.S. Saltzman, B.F. Taylor. Methyl bromide degradation by a bacterial culture grown aerobically on toluene. American Society of Microbiology 101st General Meeting, Session No. 172/Q, Abstract Q-247, p. 633 (2001).

R. Tokarczyk, E.S. Saltzman, K.D. GOODWIN, Degradation of methyl bromide in surface waters of the Atlantic and Pacific Ocean. Eos Trans. AGU, 81(48), Fall Meet. Suppl., Abstract B22A-03 (2000).

J.K. Schaefer, K.D. GOODWIN, I. McDonald, J.C. Murrell, R.S. Oremland. Methyl halide oxidation by a novel marine methylotroph, *Ruegeria* sp. strain MB2. Eos Trans. AGU, 81(48), Fall Meet. Suppl., Abstract B22A-05 (2000).

**Talks Presented at Professional Meetings** (*in addition to those listed in Abstracts*)

K.J. Harper, K.D. GOODWIN, P.H. Dutton. Progress and future directions for eDNA approaches for population assessment. US-Norway Science Round Table: eDNA – A Tool for Quantitative Assessments of Marine Ecosystems, Woods Hole, MA, May 1-2, 2018.

K. GOODWIN. NOAA 'omics research and efforts to transition into management applications and operational observations. Workshop on Enhancing Interoperability & Coordination of Long-term 'Omics Observations. Bremen, Germany, February 21, 2018. **INVITED**

K.J. Harper, K.D. GOODWIN, P.H. Dutton. Environmental DNA detection of the green turtle (*Chelonia mydas*) in San Diego Bay. Second eDNA Technical Exchange Workshop (2eDTEW Virtual Workshop) January 10, 2018.

K.D. GOODWIN. In-situ biological sensors for public health risk detection in coastal waters, Southern California Marine Microbiology Group, June 9, 2012. **INVITED**

K.D GOODWIN. 3 years, 3 beaches: *Staphylococcus aureus* and MRSA. State Water Resources Control Board, Beach Water Quality Workgroup, Costa Mesa, CA, August 18, 2010.

K.D. GOODWIN. *Staphylococcus aureus* and MRSA in the water and sand of three SoCal beaches. San Diego Microbiology Group Annual Meeting, La Jolla, CA, October 20, 2010.

K.D. GOODWIN. Technology Transfer: How to perform the microplate assay, a molecular diagnostic technique. Florida Marine Biotechnology Summit V, Gainesville, FL, November 14-15, 2006.

K.D. GOODWIN. Opportunities for marine biotechnology research and development funding. Florida Marine Biotechnology Summit IV, Boca Raton, FL, October 18, 2004. **INVITED**

K.D. GOODWIN Microbial Degradation of Halocarbons: A marine biotechnology application, Marine Biotechnology Summit III, Fort Pierce, FL, October 7-8, 2002. **INVITED**

K.D. GOODWIN. S.A. Cotton, G. Scorzetti, T.L. Kiesling, P.B. Ortner, J.W. Fell. Rapid, colorimetric detection of microbial indicators of coastal water quality. Marine Biotechnology Summit III, Fort Pierce, FL, October 7-8, 2002.

**Posters Presented at Professional Meetings** (*in addition to those listed in Abstracts*)

K.D. GOODWIN. Microbial source tracking and pathogen analysis applied to a beach with a total maximum daily load. San Diego Microbiology Group Annual Symposium, May 13, 2017.

T. Konotchick, A. Rabines, H. Zheng, S. Dovel, M. Roadman, K. GOODWIN, M. Bohan A. Thompson, C. Werner, R. Goericke, D. Checkley, A.E. Allen, NOAA CalCOFI Genomic Project (NCOG): Microbial ´omics in the Southern California Bight, CalCOFI Conference 2014, December 8-10, 2014.

N. Smith, K.D. GOODWIN, L. Edsall, M. Wood, T. Gaasterland. Methane Ice Worm (*Sirsoe methanicola*) Genome assembly and annotation from a metagenomic dataset containing prokaryotic sequences. SCASM Meetings. Southern California American Society for Microbiology Annual Meetings. 78th Annual Meeting, San Diego,. October 23-25, 2013.

K.D. GOODWIN, M. Pobuda, J. Minich, D. Weller, N. Kellar, S. Chivers, K. Danil, W. Perryman. Microbiological contaminant assessment via remote biopsy. The Society of Environmental Toxicology and Chemistry (SETAC), Pollutants in the Environment: Fate

and Toxicity Meeting, Merida, MX, August 24-27, 2011 (**JM won best student poster award**).

K.D. GOODWIN, M. Pobuda, D. Weller, N. Kellar, S. Chivers, K. Danil, W. Perryman. Microbiological contaminant assessment via remote biopsy. Southern California Marine Mammal Workshop, Huntington Beach, CA, January 9-10, 2010.

A. Abdelzaher, M. Wright, C. Ortega, A.R. Hasan, H. Solo-Gabriele, T. Shibata, J. Kish, K. Withum, G. He, S. Elmir, J.A. Bonilla, T.D. Bonilla, C. Palmer, T. Scott, G. Lukasik, V.J. Harwood, S. McQuaig, C. Sinigalliano, M. Gidley, D. Wanless, K.D. GOODWIN, L. Plano, C.A. Garza, X. Zhu, J.D. Wang, J., Stewart, H. Yampara-Iquise, C. Carson, J. Dickerson, J. Fleisher, L. Fleming,. Relationship between Measured Indicator Microbes, Pathogens, and Human Health Effect Levels in a Non-point Source Subtropical Marine Recreational Beach. Gordon Conference in Oceans and Human Health, Biddeford, Maine, June 2010.

K.D. GOODWIN and M. Pobuda. Detection of *Staphylococcus aureus* in beach water and sand – comparison of culture, immunoassay, and molecular analyses. National Beaches Conference, Huntington Beach, CA, April 20-22, 2009.

C. Sinigalliano, D. Wanless, K. GOODWIN. A rapid quantitative PCR assay for measuring the relative environmental abundance of canine-source Bacteroides. Gordon Research Conference on Oceans and Human Health, Tilton, NH, June 29-July 4, 2008.

D. Wanless, J.W. Fell, K.D. GOODWIN. Adapting the Luminex platform to coastal water quality monitoring of fecal indicators and source tracking markers. Florida Marine Biotechnology Summit V, Gainesville, FL, November 14-15, 2006.

A.S. Farmer, M.J. LaGier, K.D. GOODWIN, S. Ivanov, G. Steimle, D. Fries. Portable sensor development towards PCR-based electrochemical detection. Florida Marine Biotechnology Summit V, Gainesville, FL, November 14-15, 2006.

M.J. LaGier, J.W. Fell, and K.D. GOODWIN. Hand-held electrochemical biosensors for detection of the toxic dinoflagellate *Karenia brevis*. International Marine Biotechnology Conference Newfoundland, Canada, June 7-12, 2005.

K.D. GOODWIN. G. Scorzetti, S.A. Cotton, and J.W. Fell. Microplate detection of microbial contaminants. Environmental Protection Agency Workshop, Orlando, FL, January 29-31, 2003.

K.D. GOODWIN, K.L. Warner, I.R. McDonald, J.C. Murrell. Methyl bromide degradation by *Leisingera methylohalidivorans*, a novel pathway? The Gordon Research Conference, Molecular Basis of Microbial One-Carbon Metabolism, New London, CT, July 7-12, 2002.

**Other seminars/presentations** (*in addition to those listed in Abstracts*)

K. GOODWIN. OAR priorities: ‘omics. OAR Oceans, Coasts, and Great Lakes Portfolio Meeting. April 23, 2018.

K. GOODWIN. NOAA ‘omics. Briefing to Rear Admiral Timothy Gallaudet, April 4, 2018. **INVITED**

K. GOODWIN and M. Strom. NOAA ‘Omics collaborative activities. Briefing to Brandon Elsner, Senior Policy advisor to the Administrator of NOAA, March 16, 2018. **INVITED**

K. GOODWIN. NOAA cross-line, interagency, and international engagement in ‘omics. NOAA Research Council. February 20, 2018. **INVITED**

K.D. Goodwin, NOAA ‘Omics a brief view from the joint OAR/NMFS perspective. AOML ‘Omics Program Overview and Coordination Meeting. November 21, 2017. **PLENARY**

K. GOODWIN, NOAA research contributions to the National Microbiome Initiative. NOAA One Health Ignite Talk, July 13, 2017.

K. GOODWIN. NOAA ´Omics. Transformational Tools Strategical Applied. NOAA Ecosystem Sciences and Management Working Group, NOAA Science Advisory Board. November 20, 2016. **INVITED**

K. GOODWIN. ´Omics: An Emerging Approach to Innovate Environmental Intelligence. NOAA Ecological Forecasting Roadmap Annual Meeting. April 27, 2016. **INVITED**

K. GOODWIN and M. Strom. 'Omics. OAR-NMFS Bilateral Meeting, August 30, 2016. **INVITED**

K. GOODWIN. AOML 'omics. Atlantic Oceanographic and Meteorological Laboratory, January 12, 2016.

K. GOODWIN. Ocean Sampling Day (June 21st) and other Nifty Marine Metagenomic Projects. Northern California Water Quality Workgroup Meeting, May 14, 2015. **INVITED**

K. GOODWIN, M. Strom, M. Bohan, R. Vetter. NMFS-OAR joint collaboration: 'Omics. OAR/NMFS Science Collaboration Meeting, August 11, 2015.

K. GOODWIN. Marine Molecular Microbiology to Explore and Understand Biodiversity and Ecological Function. Ocean Sampling Day (OSD), and My Ocean Sampling Day (MyOSD) - TransAlantic Ocean Science and Ocean Literacy Online Workshop. http://www.coexploration.org/oe2015/, May 12, 2015. **INVITED**

K. GOODWIN. Ocean Sampling Day citizen science. Southern California Water Quality Workgroup Meeting, May 20, 2015. **INVITED**

K. GOODWIN and M. Bohan. NOAA-CalCOFI Ocean Genomic Project (NCOG) – Exploring ´Omics Technologies to Support Ecosystem Understanding & Fisheries Assessments. Interagency Working Group on Ocean Partnerships (IWG-OP) Biodiversity Ad Hoc Group. January 22, 2015 **INVITED**

K.D. GOODWIN, S. Huber, A. Crumpacker, S. Gruber, A. Jirik, Application of microbial source tracking for TMDL compliance, SIO Marine Biology Seminar Series, October 17, 2014.

G. Guiu, N. Valette-Silver, K. GOODWIN. Marine microbial ecology complementarities. US-EU Marine Working Group Meeting, October 1, 2014.

K.D. GOODWIN. Marine Microbial Ecology and Molecular Microbiology, Opportunities for Scientific Collaboration. US-EC Joint Consultative Group Meeting on Science and Technology Cooperation, hosted by the U.S. Department of State, Washington DC, Feb 12, 2013. **INVITED**

K.D. GOODWIN. Microbial Water Quality Assessment (MWQA) and molecular Microbial Source Tracking (MST). California Regional Water Quality Board and the Port of Los Angeles, January 18, 2013

S. Huber, K. GOODWIN, A. Crumpacker. Inner Cabrillo Beach bacteria TMDL update, Los Angeles Regional Water Quality Control Board, November 19, 2013.

A. Crumpacker, K.D. GOODWIN, S. Gruber, Prima Deshecha Cañada bacterial source ID study, stakeholder meeting, City of San Clement Public Works Department September 17, 2013

S. Gruber and K. GOODWIN. Molecular Source Tracking tools and applications. Harbor Association of Industry & Commerce, March 14, 2013.

F. Feddersen, K. GOODWIN, D. Clark, R.T. Guza. Surfzone Pollution: Using science to separate fact from fiction. Surfing Arts, Science, and Issues Conference, Scripps Institute of Oceanography, Feb. 16-17, 2013

K.D. GOODWIN. Molecular Microbiology to Explore Biodiversity, Understand Ecological Function, and Protect Health. NOAA Science Day, NOAA Headquarters, Silver Spring, January, 30, 2013. **INVITED**

K.D. GOODWIN, M. McNay, Y. Cao, D. Ebentier, M. Madison, J.F. Griffith, *Staphylococcus aureus*, MRSA, and enterococci at Southern California beaches. Scripps Institution of Oceanography Ecology Seminar Series May 2, 2012. **INVITED**

K.D. GOODWIN. Overview of the draft EPA recreational water quality criteria. Presentation to the City of San Diego Stormwater Co-permittees, January 31, 2012.

K.D. GOODWIN. Constraints on sample preparation for detection of low abundance microbial targets. Alliance for Coastal Technologies, Technical Workshop Series: Sampling the Aquatic Environment- Technologies for Sample Concentration, Remote Sampling, and Sample Return. Monterey, CA, March 29-31, 2011. **INVITED**

C. Sinigalliano et al. Protecting public health by quantitative molecular detection of gull and canine fecal contamination in recreational waters and beaches. Oceans and Human Health Symposium and Workshop, Washington DC, April 12-13, 2010.

K.D. GOODWIN and C. Sinigalliano. Development of genetic sensors to monitor waters for threats to human health (dog source tracking). Northern Gulf Cooperative Institute PI meeting, Mobile, AL, May 20 -21, 2009.

D. Wanless, K.D. GOODWIN, H. Solo-Gabriele, C. Sinigalliano. Development of environmental DNA extraction and inhibition controls for relative qPCR enumeration of fecal indicators. Oceans and Human Health PI meeting, Honolulu, HI, April 15-17, 2008.

D. Wanless, K.D. GOODWIN, C. Sinigalliano. Development of genetic sensors to monitor waters for threats to human health. Northern Gulf Cooperative Institute PI meeting, Biloxi, MI, May 12 -14, 2008.

K. Withum J. Kish, L.E. Fleming, H.M. Solo Gabriele, S. Elmir, J. Wang, J. Fleisher, L. Plano, C. Sinigalliano, M. Wright, L. Backer, A. Abdelzaher, M.B. Gidley, J. Hollenbeck, X. Zhu, F. Bonilla, T. Bonilla, T. Scott, K. GOODWIN. Pilot Epidemiologic Assessment of Microbial Indicators for Monitoring Recreational Water Quality in Marine Sub/Tropical Environments. University of Miami Research and Creativity Forum, Coral Gables, FL, April, 2008.

K.D. GOODWIN. Developing Molecular Tools and Technologies for Monitoring Coastal Quality. Southern California Coastal Water Research Project, Costa Mesa, CA, November 9, 2007. **INVITED**

K.D. GOODWIN. Emerging Tools and Technologies for Marine Biosensing. Six Decades of Fisheries Genetics Conference. Seattle, WA, September 17-18, 2007. **INVITED**

K.D GOODWIN. Biosensing to Monitor the Coastal Ocean for Threats to Human Health. Bio-sensing in Ocean Observation Workshop. Sarasota, FL, June 18-20, 2007. **INVITED**

K.D. GOODWIN. Next generation sensors for the Integrated Ocean Observing System. Public Health Risks: Coastal Observations for Decision Making, St. Petersburg, FL, Jan. 23-25, 2006. **INVITED PLENARY**

J.W. Fell, G. Scorzetti, and K.D. GOODWIN. Species-specific detection of micro-algae and bacteria with high throughput suspension array analyses. Proceedings of the Joint Meeting

for the NOAA, NSF/NIEHS Centers for Oceans and Human Health (OHH), Seattle, WA, April 24-25, 2006.

K.D. GOODWIN, S.A. Cotton, G. Scorzetti, T.L. Kiesling, and J.W. Fell. Use of immobilized DNA probes to rapidly detect sewage-indicating bacteria and toxic dinoflagellates. NIEHS-MFBS Center/ARCH Program Science Symposium, March 18, 2004.

M.J. LaGier, L. Lin, J.W. Fell, K.D. GOODWIN. Development of a remove biosensor to identify microbial contaminants using electrochemical detection of nucleic acids. University of Miami/Florida International University Joint Science Symposium, Miami, Florida, March 18, 2004.

K.D. GOODWIN. The impact of bacteria and algae on ozone-depleting compounds: Big things can come in small packages. TriBeta Biology Honor Society. University of North Alabama, 2000. **INVITED**

## Professional Affiliations/ Activities/ Service

### Professional societies/organizations

American Chemical Society (ACS), American Society for Microbiology (ASM), American Association for the Advancement of Science (AAAS)

Working to advance 'omic standards:

- Microbiome and Metagenomics Standards Alliance (IMMSA)
- National Microbiome Data Collective (NMDC) (*invited*)
- Genomics Standards Consortium (GSC)
- Taxonomic Databases Working Group (TDWG)
- The Association of Biomolecular Resource Facilities (ABRF)

Prior: Alliance for Coastal Technologies, American Geophysical Union, American Society of Limnology and Oceanography, International Society for the Study of Harmful Algae, BioFlorida, Research South Florida, European Society for Marine Biotechnology

### Editorial and technical reviews

Whole Journal:

L.G. Miller and K.D. GOODWIN, editors. Halocarbon Biogeochemistry, special issue. Biogeochemistry 60(2), 92 pages (2002)

Books, Chief Editor:

Strong, William R. One More Time, in press (2018); Shin, Jae Chul. Volume 2 The Basics, 2nd edition, in press (2018); Shin, Jae Chul. Volume 1 The Essence, 2nd edition. ISBN: 978-0-9855903-4-5 & -5-2 (2014); Shin, Jae Chul. Volume 6 The Master's Text ISBN: 978-0-9855903-0-7 & -1-4 (2012)

Article and Proposal Reviews (~5 per year):

*Journals:*

Aquatic Microbial Ecology, Applied and Environmental Microbiology, Bioscience and Bioengineering, Deep-Sea Research, Environmental Microbiology, Environmental Engineering and Management, Environmental Science and Technology, Fishery Bulletin, Harmful Algae, International Journal of Environmental Research and Public Health, Limnology and Oceanography, Marine Pollution Bulletin, Science of the Total Environment, Water, Water Research

*Proposals*:

ECOHAB, Department of Agriculture, National Science Foundation, Natural Environment Research Council, NIST Construction Grant Program, NOAA Coastal Services Center Oceans and

Human Health Initiative External Grants Program, NOAA Office of Exploration, NOAA Sea Grant, NOAA Small Business Innovative Research (SBIR), Saltonstall-Kennedy Competitive Research Program, UK SOLAS, USDA SBIR

**Membership on panels**

2017 NOAA Office of Exploration, proposal funding panel (partial panel)
2016 NOAA Office of Exploration, proposal funding panel (full panel)
2011 Technical Representative, NOAA SBIR, Phase 2: In-Field Sensors for Detection of Microbial Contaminants in Coastal Waters
2010 Technical Representative, NOAA SBIR, Phase 1: In-Field Sensors for Detection of Microbial Contaminants in Coastal Waters
2008 Ecology and Oceanography of Harmful Algal Blooms (ECOHAB), proposal funding panel
2007 Technical Representative, NOAA SBIR: In-Field Sensors for Detection of Microbial Contaminants in Coastal Waters
2007 NOAA Small Business Innovation Research (SBIR), proposal review panel: Domoic Acid Detection Kit
2006 Selection Committee, Ernest F. Hollings Undergraduate Scholarship Program
2005 Selection Committee, Ernest F. Hollings Undergraduate Scholarship Program
2005 Program Review, Tech Transfer, Cooperative Institute Coastal and Estuarine Environmental Technology (CICEET)
2004 Dissertation committee member, U. Miami Marine Biology & Fisheries (T. Kiesling)
2003 Committee member, NOAA Paper of the Year (national committee)
2003 Committee member, Faculty Search, Marine Biology and Fisheries Department, University of Miami
2002 Committee member, NOAA Paper of the Year (AOML committee)

**Advisory Services**

2018 Provided requested scientific review of position paper "Use of Marine Genetic Resources" for the September 2018 session of the Intergovernmental Conference (IGC) on an international legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ).
2018 Provided scientific input on eDNA and metagenomics to the NOAA/NMFS-Japan Fisheries Research & Education Agency 1st Bilateral
2016-2017 NOAA representative. Microbiome Interagency Working Group (MIWG), chartered by the National Science and Technology Council (NSTC) Life Science Subcommittee (LSS) of the Committee on Science (CoS)
2017 Invited panel speaker, United Nations Educational, Scientific, and Cultural Organization (UNESCO) Intergovernmental Oceanographic Commission (IOC), BBJN side event *for* "*outstanding expertise in relation to new biological observing technologies, such as eDNA*"
2017 Requested review of position paper for Biodiversity Beyond National Jurisdiction (BBJN), "Use of Genetic Resources"

2017 Marine Resources Team, An Ocean Research and Technology Plan for the United States: 2018-2028, National Science and Technology Council, Subcommittee on Ocean Science and Technology (SOST)

2015-2016 NOAA Representative. Fast Track Action Committee on Mapping the Microbiome, chartered by the NSTC/ LSS/ CoS (*NOAA Chief Scientist Nomination)*

2016 Presentation to the NOAA Science Advisory Board (SAB) Ecosystem Sciences and Management Working Group was used to inform the Report on Emerging Technologies for NOAA Ocean Research, Operations, and Management in an Ecosystem Context submitted to the NOAA Administrator.

2015 Lead Reviewer, "Use of Marine Genetic Resources" IN: First Global Integrated Marine Assessment (World Ocean Assessment), United Nations Division for Ocean Affairs and Law of the Sea (DOALOS), 2016. (http://www.un.org/depts/los/global_reporting/WOA_RegProcess.htm)

2013 Presenter to the California Regional Water Quality Board, Los Angeles Region (*science to inform implementation of the state's Natural Source Exclusion (NSE) guidance*)

2014 Congressional bill review for NOAA legal affairs, Marine Disease Emergency Act

2012 Reviewed and co-authored recommendations to the state of California regarding request for proposal (RFP) language for water quality research

2011 Development of Marine Sensors for Human and Marine Animal Health, congressional recommendations, National Council for Science and the Environment.

2005-2007 Internal Advisory Committee, University of Miami Oceans and Human Health Center

2005 Expert Science Panel Member, Near Shore Ocean Nutrification, Brevard County, Florida

**Workshops and Sessions Organized**

2017 AOML 'Omics Program Overview & Coordination with NOAA Programs, Lines, and Partners

2015 Session co-Chair, Aquatic Microbes Indicators of Ocean Changes, Coastal and Estuarine Research Federation

2011 Session Chair, Monitoring for and Forecasting Health Threats from the Oceans, National Council for Science and the Environment, Washington, DC.

2006 Planning Committee, Florida Marine Biotechnology Conference, BioFlorida

2004 Planning Committee, Florida Marine Biotechnology Conference, BioFlorida

2000 Co-chair, American Geophysical Union Fall 2000 Meeting Special Session, Global Biogeochemistry and Contaminant Transformations

**Teaching and Mentoring**

Classes Taught:

University of California San Diego

2018 Marine Micro SIO126, Microbial Water Quality Env, Feb 28

2018 Graduate Marine Biotechnology, New Methods to Monitor Organisms, Feb 13

2017 Marine Micro SIO126, Monitoring Harmful Microbes in the Marine Env, Mar 1

2016 Marine Micro SIO126, Monitoring Harmful Microbes in the Marine Env, Feb 24
2016 Marine Biotechnol SIO 242B, Pathogens, Indicators, and Biosensing, January 26
2015 Bioinformatics BILD94, Environmental Molecular Microbiology, May 12
2015 Marine Micro Lab SIO126L, Recreational Water Quality, February 4, 11, 25
2015 Marine Micro SIO126, Pathogens in the Marine Environment, February 25
2015 Marine Biotechnology SIO242B, Detecting Toxins and Pathogens, November 5
2012 Bioinformatics BILD94, Marine Biosensing, May 17
2012 Graduate Marine Biotechnology, Molecular Tools for Env Apps, May 21
2009 Bioinformatics BILD94, Marine Biotechnology, May 19

Rosenstiel School of Marine and Atmospheric Chemistry

2004-2007 Fundamental Chemical Oceanography, MAC 605 & MAC 581, Environmental Microbiology/Biogeochemical Cycling/Biodegradation lectures

California Institute of Technology

1990-1994 Teaching Assistant: Microbial Diversity (ENV 168), Environmental Biology (ENV 145), Environmental Biology Laboratory (ENV 145L)

Mentoring and Supervision:

2000-pres research staff: L. Thompson
M. Pobuda, C. Sinigalliano, S. Cotton, C. Garcia, C. Peckins, W. Jeffris
post-doctoral: K. Harper, A. Cox, M. LaGier, I. Baums, T. Kiesling
graduate: D. Voss, D. Wanless, Y. Mendoza
part-time staff: R. Struch, N. Smith, M. Zhang
work-study, senior thesis advisor: A. Sardeshmukh, L. Matragrano

Internship Sponsor:

2014 Undergraduate Summer (H. Barbour)
2012 Smith College Summer (W. Xin)
2011 Undergraduate Summer (J. Smith)
2010 NOAA Hollings Scholar (H. Spencer)
2006 NOAA Undergraduate Scholar's Mentorship ( M. Ortiz)
2005 MAST high school internship program (D. Sanjurjo)
2004 MAST high school internship program (K. Tan)

## Agency Service

**Committees** (and Working Groups)

2018 Co-Chair, NOAA Omics Taskforce
2017 NOAA Annual Operating Plan (AOP) Refresh Working Group
2017 Co-chair, 'Omics Users Group
2014-pres OAR Point of Contact, OAR-NMFS Bilateral, Genomics
2015-pres Marine Biodiversity Observing Network (M-BON) Working Group Participant
2012-pres Co-chair, NOAA Marine Microbes & Ecosystem Health Working Group (co-chair since 2014)
2010–pres Point of Contact, NOAA One Health Working Group (POC for OAR since 2012)
2013-2014 Standard Operation Procedure (SOP) Development Subcomm, Bight 13 Regional Monitoring
2012-pres NOAA Strategy, Evaluation, and Execution (SEE) response team lead, AOML

| | |
|---|---|
| 2013 | Ecological Forecasting, Pathogens Working Group |
| 2013 | Ecosystem Research Demonstration Roundtable |
| 2012 | Priority Objective Team, Ecosystem Based Management, National Ocean Policy Implementation |
| 2011 | Water Quality Objective Team (Coastal Goal) |
| 2011 | Integrated Ecosystem Assessment (IEA) Team |
| 2010 | National Ocean Policy, NOAA Engagement Strategy, Ecosystem Based Management |
| 2009–2011 | NOAA Regional Team Member, Gulf of Mexico |
| 2009–2011 | NOAA Regional Team Integrated Ecosystem Assessment Subgroups: Gulf of Mexico and California Current |
| 2009 | Strategic Goals and Objectives Workgroup Member, NOAA Coral Reef Conservation Program, Land Based Sources of Pollution Working Group |
| 2008–2014 | Gulf of Mexico Regional Alliance Water Quality Priority Team, Pathogens Workgroup |
| 2008–2009 | Tiger Team, Planning, Programming, Budgeting, and Execution System (PPBES) |
| 2008 | Ecosystem Goal Team, Integrated Ecosystem Assessments Priority Area Task Force (IEA PATT) |
| 2007–pres | California Beach Water Quality Workgroup |
| 2007–2008 | Strategic Planning Team, NOAA's Ecosystem Research Program |
| 2007 | Gulf of Mexico Coastal Ocean Observing System (GCOOS-RA), Standing Task Team on Public Health |
| 2007–2011 | Point of Contact for NOAA's Ecosystem Research Program (ERP) under PPBES (Planning, Programming, Budgeting and Execution System). |
| 2006–2007 | Writing Team, NOAA Ecosystem Goal 5-Year Research Plan |
| 2006 | Coastal Ocean Observing System - Regional Association (GCOOS-RA), Gulf of Mexico Public Health Workgroup |
| 2004 | AOML Safety Committee. Rewrote AOML chemical hygiene and hazard communication plan; implemented training, procedures, and chemical disposal |

**Other** (Agency Service)

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|---|---|
| 2017 | Genomic/eDNA Interagency Meeting, Smithsonian National Museum of Natural History, 19 January |
| 2014, 2015 | Organized NOAA participation in Ocean Sampling Day |

*Secured commitment with EU partners for NOAA samples to receive metagenomic analysis as part of the 2015 Ocean Sampling Day (OSD), an international effort to establish a Global Genomic Observatory Network. Arranged sampling from NOAA sites and through citizen science to satisfy the "next strategic level of international cooperation" for the Marine Microbial Ecology Working Group, EU-US Joint Consultative Group Meeting on Science and Technology Cooperation. Facilitated NOAA Education Office efforts to meet the demand on EU-US cooperation on Ocean Literacy as part of the Galway Statement on Atlantic Ocean Cooperation.*

| | |
|---|---|
| 2013 | Requested speaker, US-EU Joint Consultative Group Meeting on Science and Technology Cooperation |

*Meeting outcomes included the following agreed areas for collaboration: development of bioinformatics capabilities; development of standardized sample and data protocols; inclusions of microbial measurements into observing platforms; understanding of role of microbes in the ecosystems and development of biosensors*.

2011 NOAA Ecosystem Research Portfolio Workshop, November 29-December 1, Silver Springs MD

*Helped develop a comprehensive Ecosystem Research Agenda that strategically aligns and integrates the agency's science assets, partnerships and capabilities to facilitate research needed to support the sustainable use, protection, and restoration of coastal and marine ecosystems, and the resulting ecosystem services.*

2008 Integrated Ecosystem Assessments Priority Area Task Team Workshop, April 22-23, La Jolla, CA

2008 NOAA Coastal Integration Workshop, April 1-2, Silver Springs, MD

2008 NOAA Ocean and Human Health Logic Model Workshop, March 5, Silver Springs, MD

2008 Strength, Weakness, Opportunities, and Threats (SWOT) Analysis, Ecosystem Research Program

*co-authored contributions include:*

Strategic Plans and Reports:

- 2016 Chief Scientist Report, "New Frontier of Using DNA to Study Marine Life"
- Integrated Ocean Observing Systems. US IOOS Marine Sensor Technology Improvement Program A Program Plan for Transition into Operations
- Ecosystem Research Science Challenge Workshop Organizing Committee. Ecosystem Research Science Challenge Workshop: Informing NOAA's Ecosystem Research Agenda, November 29-December 1, 2011 (2012)
- Interagency Oceans and Human Health Research Implementation Plan: A Prescription for the Future. Sandifer, P., C. Sotka, D. Garrison, and V. Fay. 2007. Interagency Working Group on Harmful Algal Blooms, Hypoxia, and Human Health of the Joint Subcommittee on Ocean Science and Technology. Washington, DC.
- Research in NOAA: Toward Understanding and Predicting Earth's Environment A Five-Year Plan: Fiscal Years 2005 – 2009. January 2005 (NOAA 5-Year Research Plan)

Selected Alternatives, Initiatives, Program Change Summaries:

- NOAA ´Omics Genome-Enabled Technologies
- Advancing Technology Alternative - Ocean Research Priorities Plan BioSensors Expansion
- Integrated Ecosystem Assessment Expansion: Increasing FMPs Capability to Sustainably Manage Trust Resources
- Sensors for Marine Ecosystems
- An Ecosystem Approach to Management to Solve Regional Challenges: Predicting and Managing the Ecosystem Impacts of Water and Wastewater Release into the Coastal Zone
- Research to Sustain Human and Ocean Health in Urbanized Coastal Ecosystems of the Tropics and Subtropics

- Ensure the Development of Regionally-Specific, Integrated Ecosystem Models to Support Ecosystem Management
- Early Warning Systems: Protecting Coastal Ecosystems, Humans, and Marine Animal Health
- National Health Early Warning System
- Coastal Threats to National Security: Microbial and Chemical Contaminants, Seafood Safety, and BioSecurity

White Papers:

- Genomics: Modern techniques to address long-standing challenges in marine ecosystems and fisheries management
- Integrated Ecosystem Assessments
- A Draft Framework for Integrated Ecosystem
- Regional Ecological Forecasting Centers: Integrated Plan of Operations
- Safe and Sustainable Seafood: increased monitoring of seafood to support markets for legitimate imported and domestic products
- Health Early Warning Systems
- National Operational Harmful Algal Bloom and Microbial Contaminant Forecast System

Implementation Plans:

- Holistic Understanding Enterprise FY13-19
- Environmental Modeling FY13-19
- Oceans and Atmospheric Research, Holistic Understanding 2012
- 2011 Plans: Enterprise Goal, Coastal Goal, Marine Transportation, AOML

Performance Measure Development:

- Integrated Research Assessment (IEA) program
- Multiple AOML measures and milestones (>10)

Planning and Reporting:

- Annual Operating Plan (AOP), Budget Narrative, Balanced Score Card (BSC), SEE-wide Integration Table, Research to Application (R2A), Vlab, OAR database, Oceans Portfolio, Corporate Portfolio Analysis (CPA), NOSIA2 exercise, End-of-Year Execution Briefing, Performance and Accountability Report (PAR), Performance Operating Plan (POP), Strategic Portfolio Analysis (SPA)
- Logic Plans & Models: Health Oceans Healthy Habits; Sustainable Fish and Safe Seafood; Resilient Coastal Communities and Economies; Water Quality Objective Team; Environmental Modeling
- Report to Congress: America Competes (2012)

## Other Relevant Information

### Workshops & symposium participation

2018 eDNAta – Reviewing Existing Reference Databases. US-Norway Science Round Table: eDNA – A Tool for Quantitative Assessments of Marine Ecosystems, Woods Hole, MA, May 1-2. **Session Facilitator, INVITED**
2017 National Microbiome Data Collaboration, Washington DC, 9-10 November **INVITED**
2017 Earth Microbiome Mini Symposium, San Diego, CA 1 November
2016 Standards for Microbiome Measurements, NIST Workshop, 9-10 August
2015 MicroB3 Ocean Sampling Day (OSD) Analysis Workshop, 9-13 March **INVITED**

2011 Source Identification Pilot Project Workshop, Costa Mesa, CA, 13-14 December
2005 Autonomous Genetic Sensors, Alliance for Coastal Technologies, St. Petersburg, FL, 5-7 January

**Biological safety**

Authored laboratory biosafety manual used at AOML and SWFSC; Maintains biosafety records and biosafety cabinet certifications; Administers biosafety training & testing

**Outreach**

2018 NPR-style interview by Marine Ecology class, University of Texas, Austin, April 18.
2017 Washington Post, Health and Science Section, Beach Dangers, June 27, 2017. Acknowledged major contributor https://www.washingtonpost.com/graphics/2017/health/beach-dangers/?utm_term=.cd5825273848
2015 Ocean Sampling Day June 21, 2015: Girl Scouts, SIO pier & provided major effort as an OSD Citizen Science Hub
2014 Ocean Sampling Day June 21, 2014: Girl Scouts, SIO pier, international Ocean Sampling Day (OSD)
2013 NOAA and Our Planet Day, Aquarium of the Pacific Long Beach, November 16, ~4000 visitors
2009 Smithsonian National Museum of Natural History, Smithsonian Ocean Hall, Ocean Today Kiosk. Authored "Healthy Beaches" in coordination with the NOAA Oceans and Human Health office, http://oceantoday.noaa.gov/healthybeaches/welcome.html
2005 Featured Scientist, Our Ocean World radio segment September 22 http://www.ouroceanworld.com/2001/shows.htm
2006 Led Activity, Community Science Workshop, Children's Trust and Citizens for a Better South Florida
2006 Hands-on learning, AOML open house
2007 Guest Speaker, "Career Choices for the PhD: A Spectrum of Options" hosted by the New York Academy of Sciences, February 16
2000 Biogeochemistry: Can Biology Affect the Atmosphere? Outreach Lecture for Environmental Science High School Teachers. NOAA, Atlantic Oceanographic and Meteorological Laboratory, Miami, FL